

12th Physics Notes - Wave Theory of light

JEE Main 2014 Preparation

Explain any two Applications of Doppler Effect in Light.

Doppler shift in frequency or wavelength of electromagnetic radiations is used

1.) by astronomers to determine the radial velocities along the line of sight of stars and galaxies. From the Doppler red-shifts of galaxies, we infer that the universe is expanding, which is one of the most important pieces of evidence in support of the Big Bang model. Distant galaxies are moving away from us extremely fast, faster than nearer galaxies.

2.) by astronomers to determine the rotational speed of the Sun from the Doppler shift in the Fraunhofer lines in the solar spectrum from the two diametrical ends of the solar disc. Some of the absorption lines in the solar spectrum are due to absorption by atomic oxygen in the Earth's outer atmosphere. Hence, coinciding the atmospheric oxygen lines in the two spectra, the Doppler shifts of lines from iron are measured. As the Sun rotates about its axis, one end approaches us, while the other end recedes away. Measurements show that the rotational speed of the Sun at the equator is nearly 2 km/s.

3.) In plasma physics to estimate the temperature of a plasma which is emitting a spectral line. Plasma is a state of matter similar to gas in which a certain portion of the particles is ionized.

The net charge of a plasma is roughly zero. Very high temperatures are usually needed to sustain ionization. Plasma temperature is commonly expressed in Kelvin or electronvolt (a unit of energy).

Due to the thermal motion of the ions, the light emitted by each particle can be slightly red – or blue-shifted depending on whether the ion is moving towards or away from the observer; the magnitude of the shift is proportional to the velocity along the line of sight. The net effect is a broadening of the spectral line. The width of the line is proportional to the square root of the temperature of the emitting ions, allowing a Doppler broadening of spectral line to be used to infer their temperature.

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